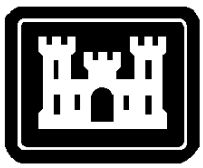

US Army Corps
of Engineers
Hydrologic Engineering Center

Hydrologic Modeling System HEC-HMS

Release Notes

Version 2.0
March 2000

Introduction

The Hydrologic Modeling System (HEC-HMS) is designed to simulate the rainfall-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems. The program features a completely integrated work environment including a database, data entry utilities, computation engine, and results reporting tools. A graphical user interface allows the user seamless movement between the different parts of the program.

Installation

It is recommended that existing installations be uninstalled before installing the current version. Windows NT computers require manual removal of the HMSPROJHOME and UNIDIR user environment variables under the System settings on the Control Panel. Complete installation instructions can be found in Chapter 2 of the User's Manual.

For New Users

The program has been designed to be easy to use. However, an understanding of how the program works is critical to producing accurate results. It is suggested that a new user read Chapter 3 of the User's Manual before attempting to start and use the program. Subsequently, start the program and construct the example application contained in Chapter 10. These two chapters provide the fundamental instruction necessary to effectively use the program.

For Experienced Users

The User's Manual has been dramatically expanded to include information on every aspect of the program. A Technical Reference Manual is also available. It is recommended that experienced users read the topics, both in the User's Manual and Technical Reference Manual, for computational methods used frequently.

What's New In Version 2.0?

The Continuous simulation capability is greatly expanded with the soil moisture accounting loss method and linear reservoir baseflow method. The loss method uses a five-layer storage model with evapotranspiration to model canopy interception, surface

depression storage, the soil profile, and two groundwater layers. Outflow from groundwater layers can be connected to the linear reservoir baseflow method to compute channel baseflow.

It is now possible to use the gridded precipitation method with all transform types. The program automatically determines whether the selected transform is lumped or distributed. An area-weighted average hyetograph is computed for subbasins using a lumped transform. Gridded precipitation data is used directly for a distributed transform. Subbasins using a lumped transform and gridded precipitation must have a grid-cell file in order to compute the hyetograph.

More parameters can be calibrated with the optimization manager. Additional parameters that can now be calibrated include: loss rate scale factors, ModClark transform parameters, and loss rate parameters when the ModClark transform is selected.

It is now possible to view simulated flow in terms of stage. A stage-discharge curve can be entered at any element in a manner very similar to specifying an observed hydrograph. During a simulation, the flow is computed first and stage is computed from flow. Graphs, summary tables, and time-series tables include the computed stage.

Error messaging has been significantly improved. Message logs are now available for the project, imports, each run, and each optimization run. Additional messages not previously available are summarized in Table 1.

Table 1. New error messages in Version 2.0

Program Area	Description
Kinematic Wave	Note reporting volume check.
Kinematic Wave	Warning for low channel slope.
Muskingum-Cunge	Note reporting delta x and delta t used.
Muskingum-Cunge	Warning for low channel slope.
Reach Element	Warning indicating number and volume of negative inflow values.
SCS Curve No.	Warning when initial abstraction ratio is out of bounds.
Snyder Transform	Warning indicating parameter values used when convergence fails.
Source Element	Error indicating DSS gage data is missing.

What's Changed From Version 1.1?

The most significant change from previous versions is the replacement of the *Precipitation Model* by the *Meteorologic Model*. Currently the meteorologic model contains a precipitation and evapotranspiration module. The precipitation module contains all of the functionality encompassed by previous program versions. The evapotranspiration module is only required when continuous simulation will be performed.

The interpolation method for the frequency storm precipitation method uses linear interpolation between depth-duration data points. The previous version interpolated from a second-order polynomial fit to all data points.

The *Simulation Manager* has been renamed *Run Manager* to comply with new terminology standards. The standards will ensure consistency across all HEC computer programs.

The *Edit* menu on the *Project Definition* screen has been replaced with *Component* and *Data* menus. The component menu includes capability for creating, opening, deleting, and importing basin models, meteorologic models, and control specifications. The data menu provides access to precipitation gages, discharge gages, and soil moisture accounting units. This change was necessary to accommodate future designs that will greatly increase the amount and types of data managed by the project.

The *Area/Base Flow Editor* in the basin model has been replaced by a *Subbasin Global Editor* and three separate base flow global editors for the different base flow methods.

The SCS curve number loss method now allows specifying initial loss, I_a, of zero. It is computed automatically as $I_a = 0.2S$ when no value, *i.e.* blank, is specified. The previous version automatically computed the initial loss when the value was zero.

The HEC-1 objective function has been renamed peak-weighted root mean square error to more accurately describe its formulation.

What Errors Have Been Corrected?

Many errors discovered in the previous version have been corrected. A total of 29 high priority, 91 medium priority, and 58 low priority items were found and corrected. The most significant items are noted in Table 2.

Table 2. Major error corrections in Version 2.0.

Program Area	Description
Diversion Element	The flow-diversion table is no longer extrapolated.
Gage Manager	Latitude and longitude minute and second values exceeding 59 are now correctly handled.
Gage Manager	Time window selection problems when viewing graphs are corrected.
Gage Manager	Two external DSS gages can now have the same pathname if they are stored in different files.
Open Project	Problems with the drive selector on the unlisted projects tab are corrected.
Optimization	Deletion of components used in an optimization run no longer causes the program to crash.
HEC-1 Import	Full support for PB, PC, PI, PG, PR, PT, and PW records is provided.
HEC-1 Import	The storm frequency on the PH record is now set correctly.
Reach Element	Missing data are no longer interpreted as negative flow.
Reservoir Element	Unit conversion problems in the elevation-area-outflow input option are corrected.
Run Configuration	Problems selecting components while configuring a run are corrected.
Save Project	Space problems when saving a project to a diskette are corrected.
Standard Project Storm	Bounds checking is now performed on the parameters.
Subbasin Element	The total surface runoff volume calculation is now performed correctly.
User Gage Weights	Cumulative precipitation data is correctly converted to incremental data.
Optimization	Previous results are no longer overwritten when a run has more than one location.
Kinematic Wave Transform	Memory problems when one or both planes produce zero flow are corrected.
User Unit Hydrograph	The ordinates of the user-specified unit hydrograph are now correctly stored and retrieved in DSS.

What Errors Have Not Been Corrected?

Printing graphs continues to be a problem when the program is running on Windows 98/95 computers. The most serious errors have been resolved and it is now possible to successfully print graphs. However, two spurious pages are printed after the page containing the graph. We will continue to address this problem in the future and hope to provide a complete solution.

The program will stop running when attempting to delete a project stored on a diskette that is not in the proper drive. Diskettes and other removable media should only be used for archive purposes. To avoid this problem: deselect the "add to project list" checkbox when making the archive copy of a project.

The program will stop running when the Parameter Summary screen for viewing optimization results is left open while optimizing trials that provide data to the open screen. To avoid this problem: close the screen before optimizing.

The program will stop running when selecting a gage from the Meteorologic Model if one of the gages in the Precipitation Gage Manager is using gridded data. Gridded data is accessed directly by the meteorologic model instead of through the gage manager. To avoid this problem: external DSS gages should not be created that use gridded data.

The program will experience significant but non-catastrophic problems if the optimization manager is used at the same time basin models or control specifications are manipulated. To avoid this problem: close all screens except the project definition screen before using the optimization manager.

What's Different From HEC-1?

The recession baseflow method includes a recession constant for specifying the rate at which recession flow decreases with time. In HEC-HMS the parameter is defined as the ratio of the current recession flow to the recession flow one day earlier. In HEC-1 the parameter, called RTIOR, is defined as the ratio of the current recession flow to the flow one hour later. The following equation can be used to convert an HEC-1 recession constant for use in HEC-HMS:

$$Recession\ Constant = \frac{1}{(RTIOR)^{24}}$$

The Clark method produces a unit hydrograph that theoretically has an infinite number of ordinates, because each ordinate on the tail of the unit hydrograph is computed by multiplying the preceding ordinate by a constant fraction. In both HEC-HMS and HEC-1, the tail of the unit hydrograph is truncated when the volume represented by the unit hydrograph exceeds 0.995. In HEC-HMS the ordinates are then adjusted to produce a volume of 1.000. No adjustment is made in HEC-1.

Hydraulic properties of channels with prismatic cross sections are computed differently in HEC-HMS and HEC-1. In HEC-HMS properties are computed from the physical properties of the channel, whereas in HEC-1 the properties are computed with formulas based on the kinematic wave assumption. In HEC-HMS the cross-sectional flow area is computed as:

$$A = y(w + z\,y)$$

and the ratio of wave speed, *c*, to flow velocity, *v*, is:

$$\frac{c}{v} = \frac{(10\,w\,z\,y) + \left(16\,z\,y^2\sqrt{z^2+1}\right) + \left(5\,w^2\right) + \left(6\,w\,y\sqrt{z^2+1}\right)}{2(w + 2\,z\,y)\left(w + 2\,y\sqrt{z^2+1}\right)}$$

where *w* is the bottom width, *z* is the side slope, and *y* is the flow depth. Velocity is computed using Manning's formula. In HEC-1 the cross-sectional flow area is computed as:

$$A = \left(\frac{Q}{\alpha}\right)^{\frac{1}{m}}$$

and the wave speed, c, is computed as:

$$c = \alpha\,m\,A^{m-1}$$

where α and *m* are kinematic parameters based on the channel shape.

Hydraulic properties of channels with 8-point cross sections are computed differently in HEC-HMS and HEC-1. In HEC-HMS the flow depth for a given discharge is determined from the cross-sectional characteristics and then area, top width, and wave speed are computed for that depth using the cross-sectional data. In HEC-1 the discharge, area, top width, and wave speed are computed for 20 depths and stored in a table. During the routing process, area, top width, and wave speed are interpolated from the table for each discharge value.

Future Plans

Planning is under way for three versions beyond the current release. Planning and design of future versions is a dynamic process and features for each version do change over time in response to funding and field requests. The following descriptions should be used as a general outline when anticipating new features.

Increased efficiencies in the user unit hydrograph transform method will be the focus of the first version. The specification of hydrographs will be centralized in a new paired-data manager. It is planned to allow incremental hydrographs with a fixed time base or dimensionless cumulative s-graphs. The unit hydrograph duration will automatically be adjusted to match the simulation time step. Other paired-data such as stage-discharge curves will receive similar treatment.

Improved reservoir modeling will be the focus of the second version. Specification of outlet structures such as pipes and box channels will be included in the element definition. Spillway structures such as broad and ogee weirs will also be included. Additionally, dam break capabilities similar to HEC-1 will be added.

Efficiency tools for planning studies, where the product is a frequency curve, will be the focus of the third version. Additional visualization capabilities will create graphs and tables of results from several elements or simulation runs. Report tools will be added to create appendix-quality records of basin or meteorologic model data.

Documentation

The *Hydrologic Modeling System HEC-HMS: User's Manual* contains extensive information on installing and using the program. An example application is included to illustrate the steps necessary to produce results.

The *Hydrologic Modeling System HEC-HMS: Technical Reference Manual* contains information on how to use the various methods included in the program. The scientific origin and equation derivations are presented for each method. Specific solution algorithms for a method are discussed when necessary for a complete understanding. Application and parameter estimation for each method is also included.

The online help system within the program contains topics describing each screen of the graphical user interface.

Support Policy

Technical support for program users within the Corps of Engineers is provided through an annual subscription service. Subscribing offices can expect full support from HEC staff in the routine application of the program. Users are strongly urged to consult with HEC staff on the technical feasibility of using the program before beginning a project with unique requirements such as grid cell hydrology, snow melt, or continuous simulation. Extended support for large or complex projects can be arranged with a contract agreement.

Support can not be provided to users outside the Corps of Engineers. Domestic and foreign vendors are available that provide fee-for-service support similar to the support provided to subscribing Corps offices. Such service agreements are between the user and the vendor and do not include HEC staff. Vendors do contact HEC on behalf of their users when unusual problems or errors are encountered.

Reporting of suspected program errors is unrestricted. We are continuously working to improve the program and possible bugs should always be reported. Reports should include a written description of the steps that lead to the problem and the effects that result from it. We will reply to all correspondence concerning program errors.

Request support or report program errors through the following channels:

- Call (530) 756-1104, 7:30 am to 4:30 pm PT Monday through Friday.
- Fax (530) 756-8250 any time.
- Write to U.S. Army Corps of Engineers, Hydrologic Engineering Center, 609 Second Street, Davis, CA 95616-4687 USA.
- Send email to *hms@usace.army.mil* on the internet.
- Visit our web site at *http://www.hec.usace.army.mil*.